

The LIGO Science Education Center in Livingston, Louisiana.

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LIGO

Partnership formed

Began by first LLO site head, Mark Coles, with early involvement by Steve McGuire at SUBR



- Cutting-edge Scientific research laboratory / Observatory.
- Local research university with Education college and LIGO science collaboration membership.
- State education agency.
- Informal learning center, with long and broad experience.

- Southern University, Baton Rouge
- Laser Interferometer Gravitational-wave Observatory, Livingston, Louisiana.
- Louisiana Gaining Early Awareness and Readiness for Undergraduate Program / Louisiana Systemic Initiatives Program
- San Francisco Exploratorium
- Baton Rouge Area Foundation



Southern University at Baton Rouge (SUBR)

“SUBR is a comprehensive institution offering four-year, graduate, professional, and doctoral degree programs. The University is part of the only historically black Land Grant university (HBCU) system in the United States.”

Founded: 1880

Accreditation: Fully accredited by the Southern Association of Colleges and Schools (SACS).

Enrollment: An average of 8,000 students at SUBR each year.

Programs: Bachelor's in 42 areas, 20 master's, 5 doctoral and 3 associate degrees.

No. of Faculty: 570

No. of Colleges 7



Southern University

College of Education

College of Sciences

- Dept of Physics
- Dept of Mathematics

- A Leading producer of teachers in LA

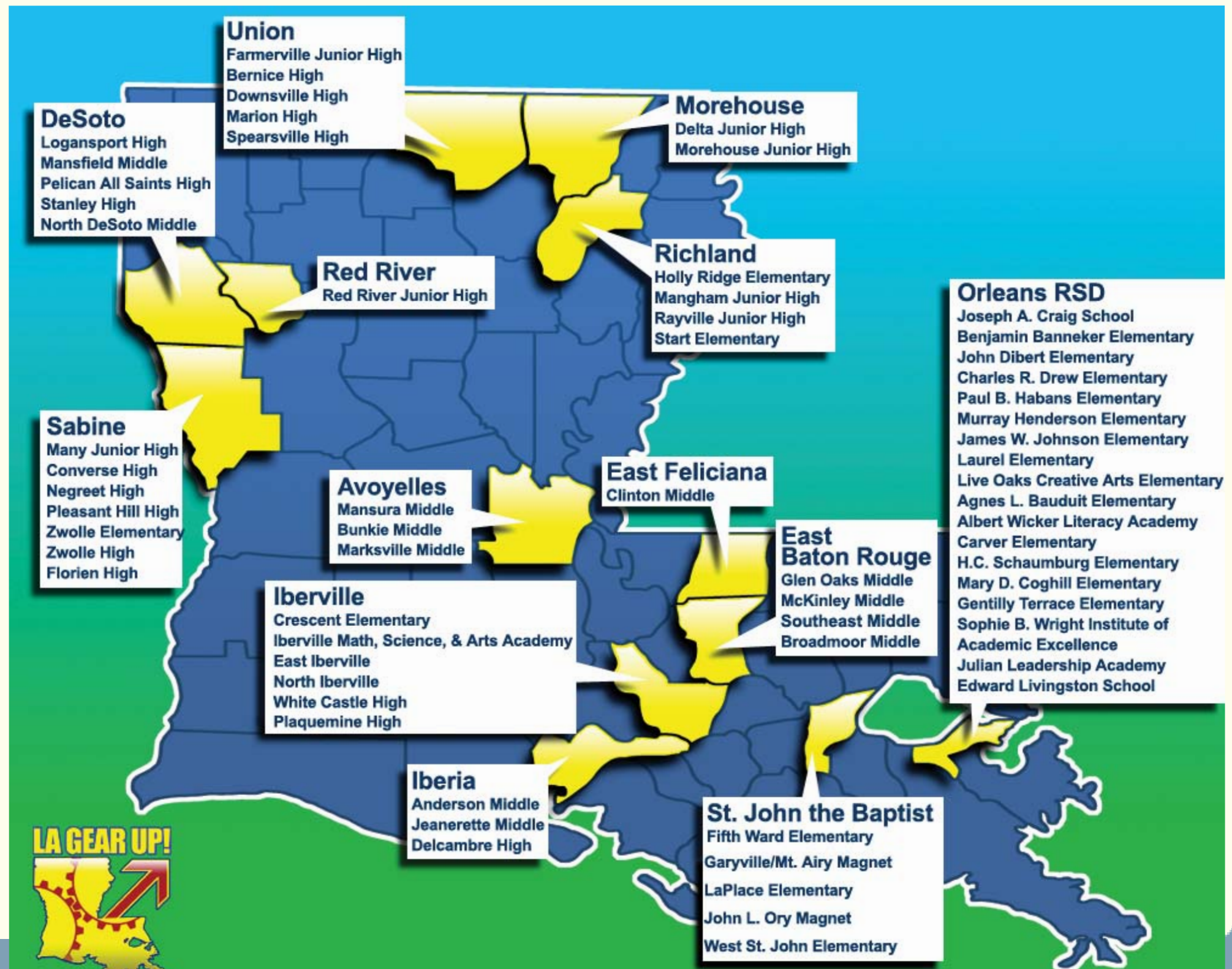


- Course Redesign
- E-Learning
- Pre-service Teacher training
- Docent training
- Student Field Trips

LA GEAR UP

Louisiana Gaining Early Awareness and Readiness
for Undergraduate Programs

- State K-16+ educational reform agency
- School connections
- Teacher Professional Development





Exploratorium

- The Exploratorium is a museum of Science, Art, and Human Perception. Founded by Frank Oppenheimer in 1969.
- The Exploratorium Teacher Institute provides science and mathematics content-rich workshops to high school and middle school science teachers, and to professional development specialists.

Teaching & Learning



- Shared goal of partnership members.
- Children of all ages benefit from direct acquisition of natural-world knowledge.
 - » We can use it directly, as in the art of pouring liquid without spilling it, in cooking without poisoning, in sports without injury, in carpentry without collapse, and in almost every human endeavor that involves getting up.
 - » Yet, students perennially lack the targeted experiences, or the careful appreciation of them, that would help them to acquire physical intuition for basic science curricula.



Sierra = "XVII-15-IX"

or Sierra = the feel, smell, and sight of the fish

The oneness of these two might take its contribution from both. For example: the Mexican sierra has "XVII-15-IX" spines in the dorsal fin. These can easily be counted. But if the sierra strikes hard on the line so that our hands are burned, if the fish sounds and nearly escapes and finally comes in over the rail, his colors pulsing and his tail beating the air, a whole new relational externality has come into being—an entity which is more than the sum of the fish plus the fisherman. The only way to count the spines of the sierra unaffected by this second relational reality is to sit in a laboratory, open an evil-smelling jar, remove a stiff colorless fish from formalin solution, count the spines, and write the truth "D. XVII-15-IX." There you have recorded a reality which cannot be assailed—probably the least important reality concerning either the fish or yourself.

It is good to know what you are doing. The man with his pickled fish has set down one truth and has recorded in his experience many lies. The fish is not that color, that texture, that dead, nor does he smell that way.

Such things we had considered in the months of planning our expedition and we were determined not to let a passion for unassailable little truths draw in the horizons and crowd the sky down on us. We knew that what seemed to us true could be only relatively true anyway. There is no other kind of observation. The man with his pickled fish has sacrificed a great observation about himself, the fish, and the focal point, which is his thought on both the sierra and himself.





“There have been many attempts to bridge the gap between the experts and the laymen. The attempts have involved books, magazine articles, television programs and general science courses in schools. But such attempts, although valuable, are at a disadvantage because they lack props; they require apparatus which people can see and handle and which display phenomena which people can turn on and off and vary at will. Explaining science and technology without props can resemble an attempt to tell what it is like to swim without ever letting a person near the water. There is thus a growing need for an environment in which people can become familiar with the details of science and technology and begin to gain some understanding by controlling and watching the behavior of laboratory apparatus and machinery; such a place can arouse their latent curiosity and can provide at least partial answers.”

- FRANK OPPENHEIMER Curator 11 (3) 1968

LIGO

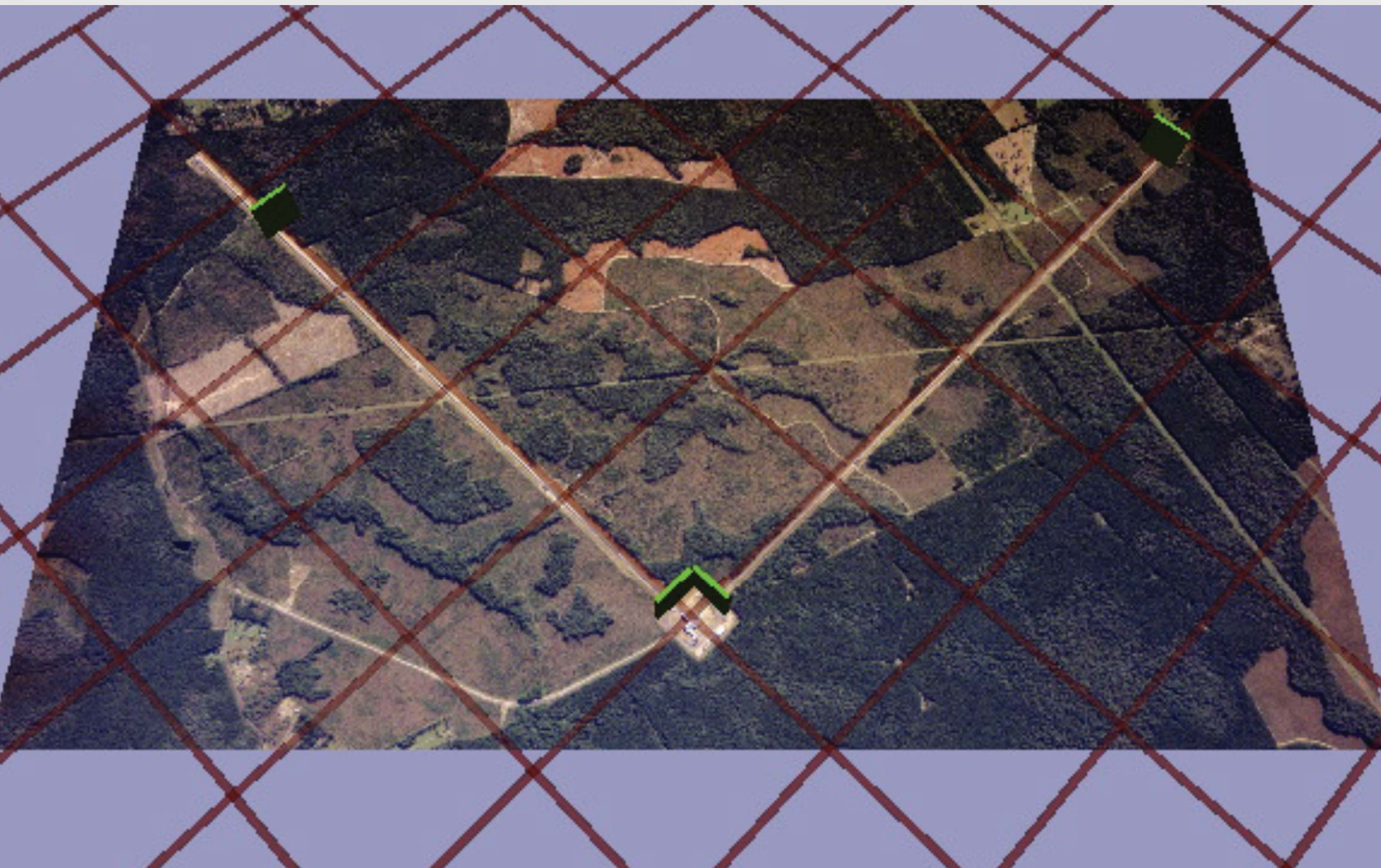
The LIGO Livingston Observatory



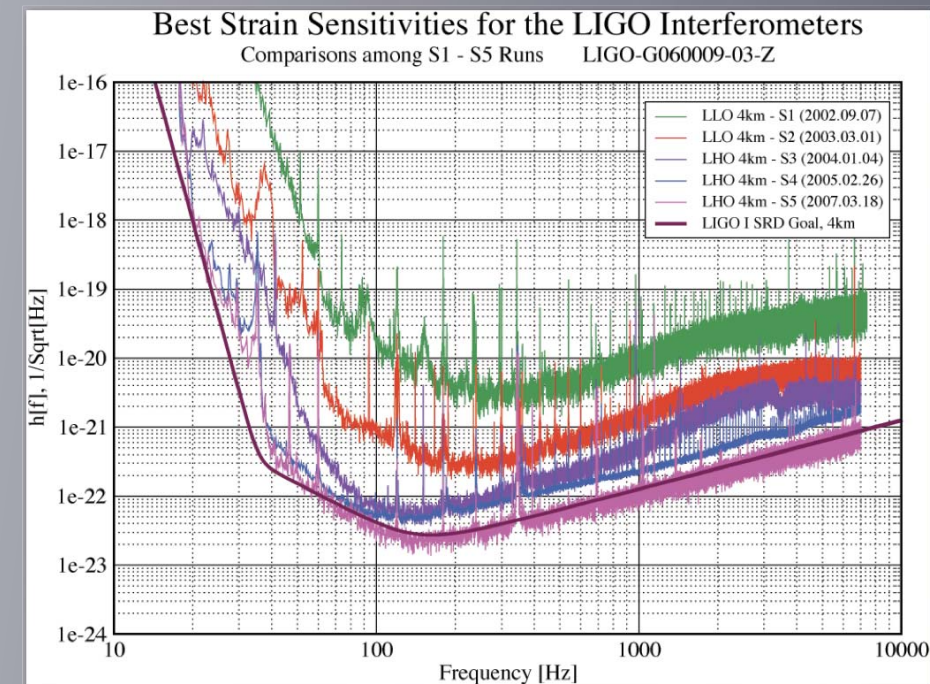
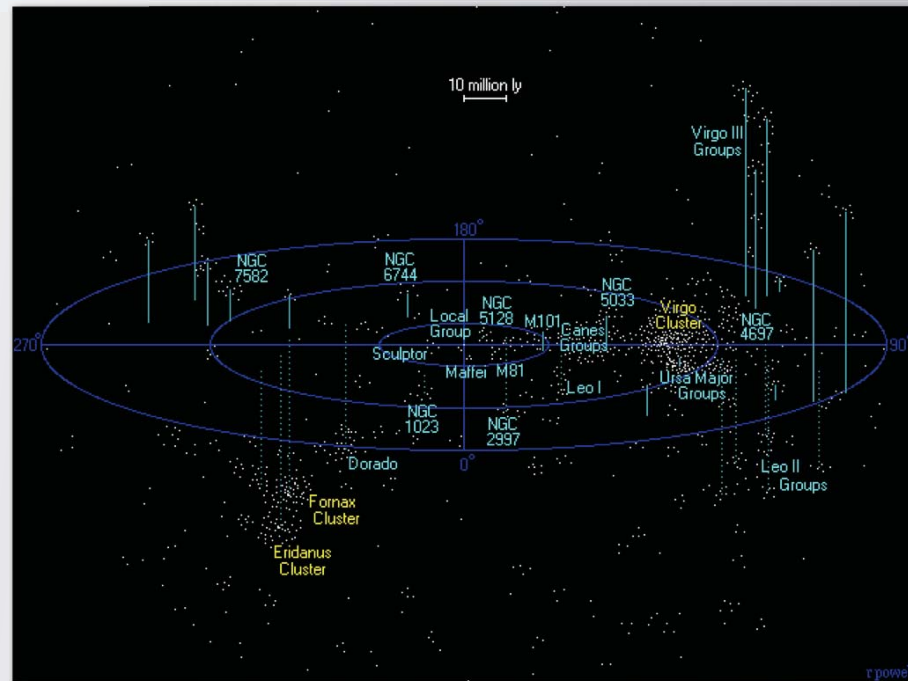


Slightly exaggerated effect of GWs on LIGO detector.

AMNH animation



41 orders of magnitude in length



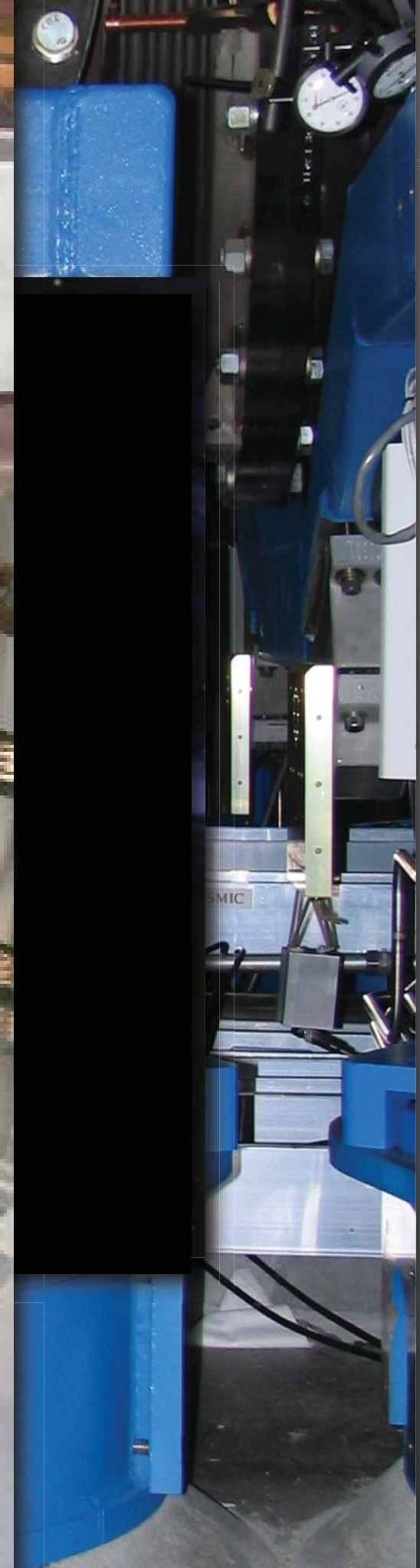
Clusters of Galaxies

$$5 \times 10^{23} \text{ m}$$



Extreme sub-atomic lengths

$$10^{-18} \text{ m}$$





the LIGO SEC building

- Funded through an NSF cooperative agreement with Caltech, as part of LIGO SEC partnership.
- 840 m² facility, with 460 m² of exhibit space, a 30-student classroom, two offices and rest rooms. (9000 sq foot, 5000 sq foot.)
- Connected to pre-existing building with 150 seat auditorium, machine shop, and offices of many of LLO's staff.
- Just across the street from the observatory control room.
- Facade incorporates kinetic sculpture that is a coupled pendulum science exhibit.



- A new regional Science Education Center with over 40 interactive, hands-on exhibits that are themed to LIGO science has been established. Since 2005, there have been over **3000** teacher training days (representing half the parishes in the state) and over **6000** student visitor days.
- SEC acts as a research lab for three ongoing education research projects (visitor studies) under a formal agreement with Tulane University. Dr. Lisa Szechter, for whom a month of annual summer salary is requested in this new proposal, and her students, have carried out research there that has led to two theses (M.S. and honors) and several papers and presentations.
- SEC staff has received extensive Exploratorium training in exhibit-based science content teaching and learning. They have consequently developed a multi-layered, content-rich library of programs themed to LIGO science. The programs conform to LA state education standards, and are appropriate for both school visits and teacher professional development;
- Evaluation has been carried out by Inverness Associates.





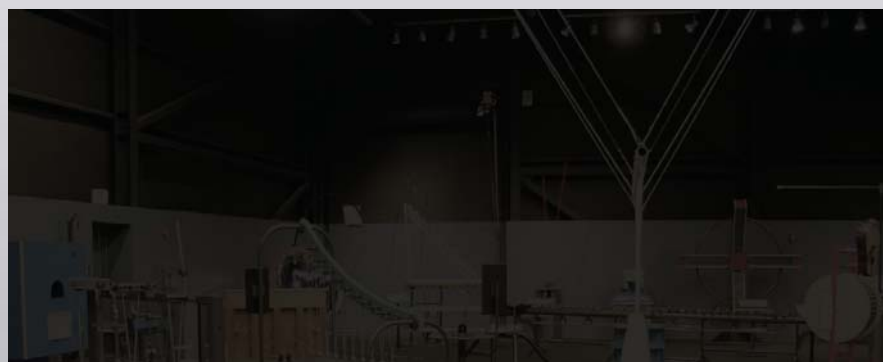
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LIGO

Visit to the LIGO Science Education Center



Hands-on Lesson

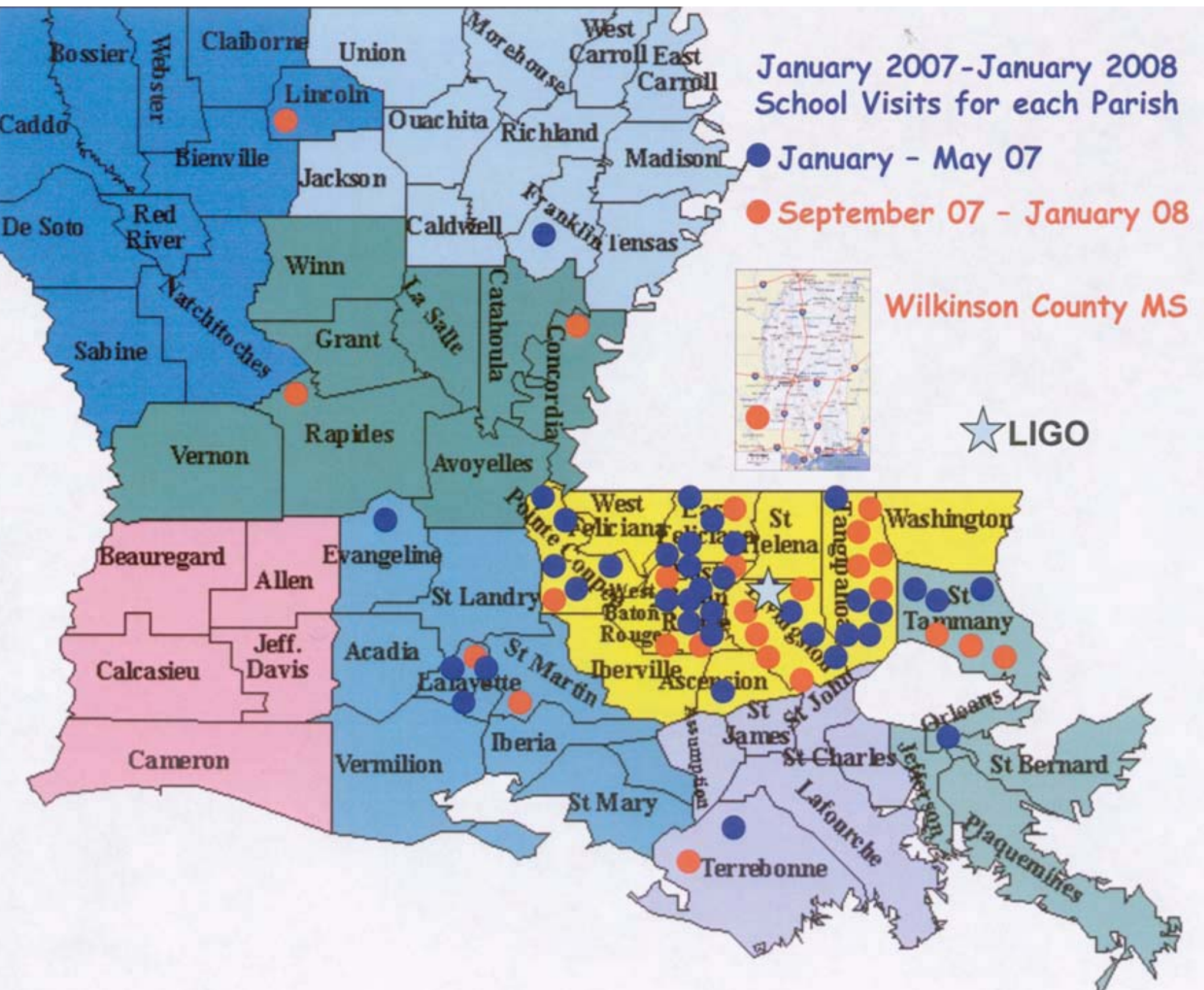
Teachers choose programs.
Available programs keyed to State science curriculum.



Exhibit Play



School and teacher PD Visits



5000 students
3000 teacher-
days

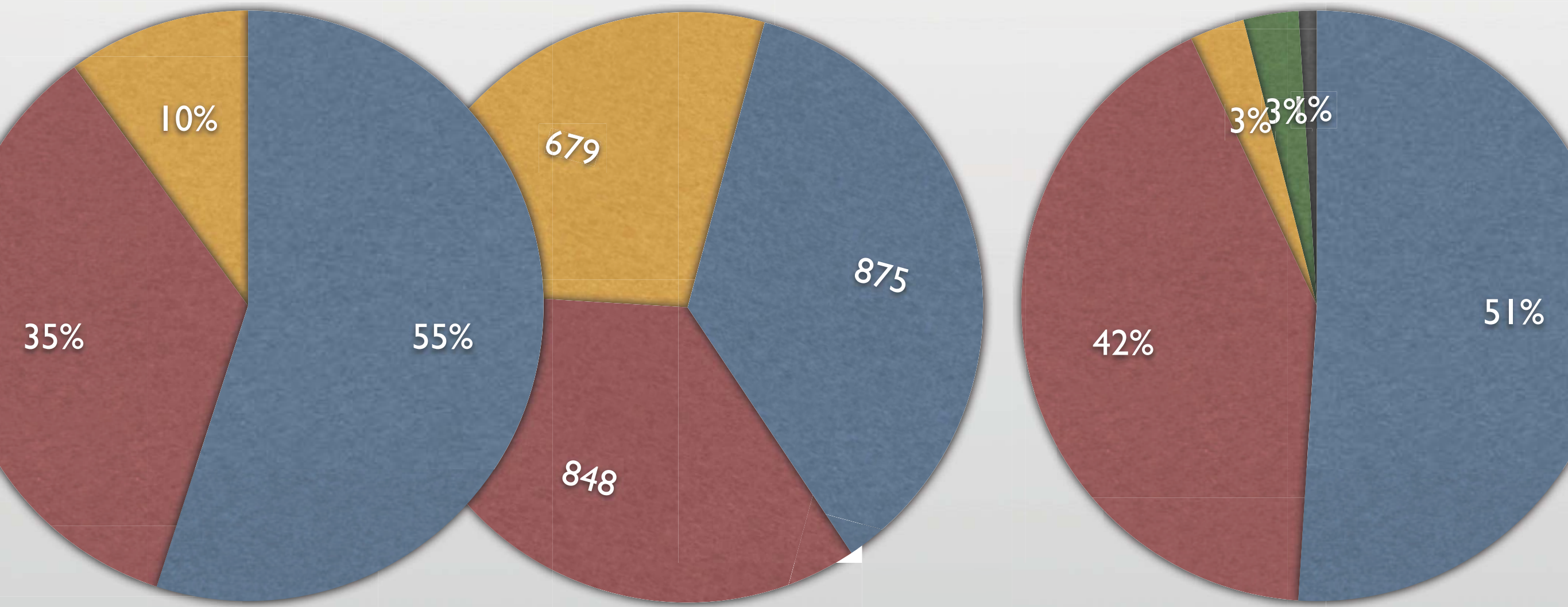
hundreds of
public tours

and more to
come!

- Students
- Teachers
- Public
- Elementary School
- Middle School
- High School
- Black
- White
- Hispanic
- Asian/Pacific Islander
- Native American

About 28 teach PD ‘events’ last year, of which 12 were MSP’s, 8 LaGearUP workshops, and 8 organized by various other organizations

Also, REU and RET students at LIGO every Summer.



Informal Learning Research

Lisa Szechter, Tulane

- Attitudes
 - Examined whether and how visits to LIGO SEC impact students' attitudes toward science
- Exhibit Interactions
 - Measured time spent by school groups and coded for questions, predictions, explanations, demonstrations
- Parent-Child Conversations
 - Studied unstructured visits to the exhibit hall looking at individual and exhibit differences

Example Results: Factor Analysis

- **Personal Interest in Science**

“I would enjoy being a scientist.”

- **Views of Science & Scientists**

“Scientists are among the smartest people.”

- **Utility of Science**

“Thinking like a scientist is only useful when taking a test in science class.”

Results

- Before vs. After LIGO Visit (Time)
 - Students were more likely to endorse **Personal Interest in Science** items after their visit than before, $M = 4.72$ and 4.52 , respectively, $F(1,553) = 19.40$, $p = .00$
 - Students were more likely to endorse **Views of Science and Scientists** items after their visit than before, $M = 4.42$ and 4.22 , respectively, $F(1,553) = 18.34$, $p = .00$

Results

- Time x Grade

- Older students increased their endorsement of **Personal Interest in Science** items ($M = 4.38$ pre and 4.67 post) to a greater extent than younger students ($M = 4.66$ pre and 4.76 post), $F(1,553) = 4.06$, $p = .04$.

- Grants from NSF to Caltech and Southern University, 4/'04–3/'09. Very briefly, these funds used for:
 - » LIGO SEC building and its 40 exhibits, plus SUBR Inquiry Laboratory on campus.
 - » Training of teachers, students and docents, directly by the partners, or facilitated by Center users from other institutions.
 - » Educational research, course redesign, etc.
- Initial award letters specified that the partners create overall “Directorate” that would ensure partner programs would be carried out in a highly collaborative way.
- This led to multi-institution working groups to (among other things) write a set of **bylaws** and to plan a **next phase** of activities.
 - » **Bylaws** clarified partnership goals, as well as the rights and obligations of partners, the membership of the Directorate and an Executive Committee, and a procedure to add affiliates and member organizations.
 - » **Next Phase** committee created consensus plan to further advance our goals.

Furthering the goals

- Partnership shared goals:
 - » Communicate LIGO-related scientific concepts to the public.
 - » Strengthen in-service and pre-service science teaching.
 - » Reach a broad audience of students in Louisiana and the surrounding region.
 - » Integrate LIGO SEC outreach initiatives in statewide educational and regional public information efforts.
- Next phase activities:
 - » **A Science Education Continuum of Engagement:** we want to reach a range of ages, circumstances and levels of interest to advance Louisiana science literacy and attitudes. In addition to the SEC's ongoing programs, we target specific activities:
 - *teacher training:* training and development of new program material, tests with repeated visits. continuation of SUBR & LA GEAR UP training programs.
 - *student learning:* docents, SUBR inquiry laboratory, targeted student programs at the SEC,
 - *public science literacy:* More emphasis on Saturday family programs.
 - » **Research, Evaluation and Dissemination:**
 - *Education and Learning research, using data taken from program participants and special visits, evaluated by Szechter and colleagues. SUBR Science/Mathematics Education Doctoral program (SMED) graduate students will be involved in intensive educational research studies of visitors (these are also a form of evaluation)*
 - *Evaluation via internal data collection/ analysis, plus external evaluation company, Inverness.*
 - *Dissemination: planning to host national meeting to encourage similar partnerships, engagement through membership in, and communication with, local and national organizations.*
 - » the **LIGO SEC facility and staff**, funded through a separate LIGO Operations cooperative agreement, will continue hosting student and teacher groups.

Proposed resource flow

